

(12) UK Patent Application (19) GB (11) 2 131 063 A

- (21) Application No 8309866  
(22) Date of filing 12 Apr 1983  
(30) Priority data  
(31) 443027  
(32) 19 Nov 1982  
(33) United States of America (US)  
(43) Application published 13 Jun 1984  
(51) INT CL<sup>3</sup>  
E02D 3/08 17/20  
(52) Domestic classification  
E1F 6  
E1H JA  
(56) Documents cited  
GBA 2073281  
GBA 2059484  
GB 1485004  
GB 1453537  
(58) Field of search  
E1F  
E1H  
(71) Applicant  
Atlas Industries Limited  
(Hong Kong),  
1004 Hang Seng Bank,  
TST Branch Building, 18  
Carnarvon Road,  
Kowloon, Hong Kong  
(72) Inventor  
William Kent Hilfiker  
(74) Agent and/or Address for  
Service  
Barlow Gillett & Percival,  
94 Market Street,  
Manchester M1 1PJ

(54) Method of and apparatus for retaining earth formations

(57) A retaining structure for an earthen formation includes a plurality of welded wire gridwork mats 11 disposed in vertically spaced relationship with compacted earth and soil disposed therebetween. At the face of the earthen structure, a course of corrugated welded wire backing mats 12 is joined to the edges of the

gridwork mats 11 with the corrugation vertices extending generally vertically. A second layer of corrugated welded wire facing mats 13 may be joined to the vertical corrugated mats 12, with the second layer of mats 13 having corrugation vertices extending horizontally. The corrugated mats 13 stabilize the face of the formation, and may comprise the reinforcing members of a concrete retaining wall cast in place at the face of the formation.

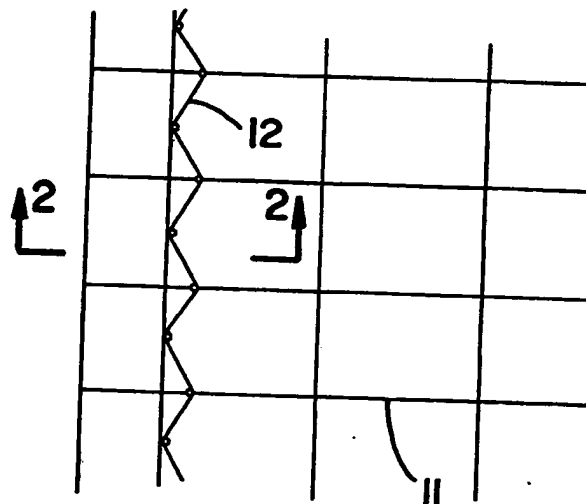


FIG - 1

BEST AVAILABLE COPY

GB 2 131 063 A

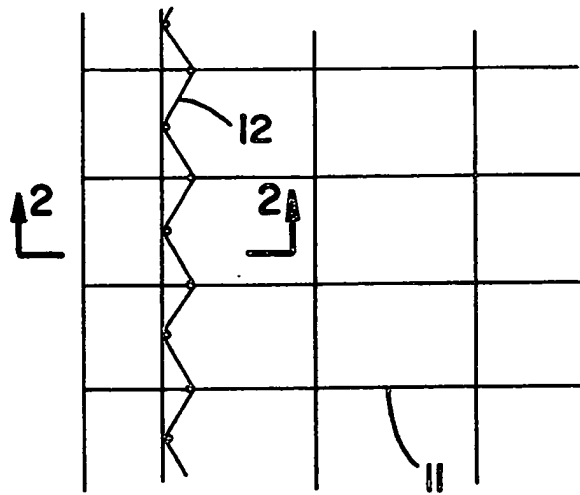


FIG. 1

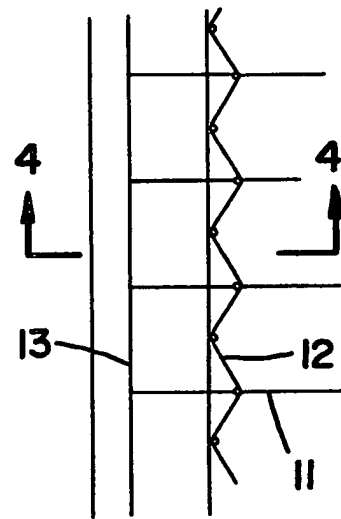


FIG. 3

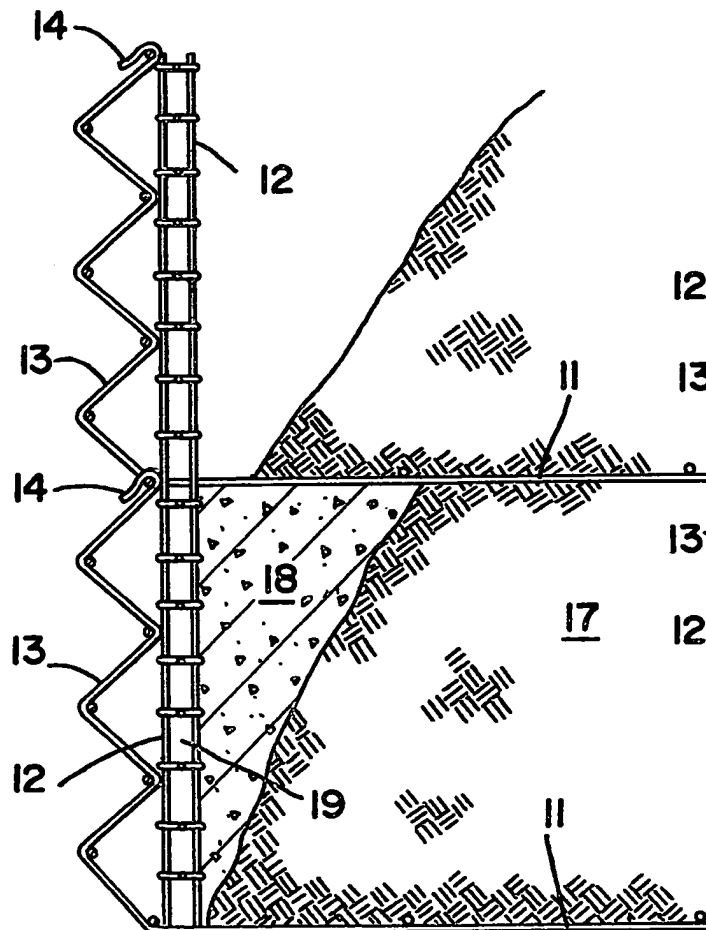


FIG. 2

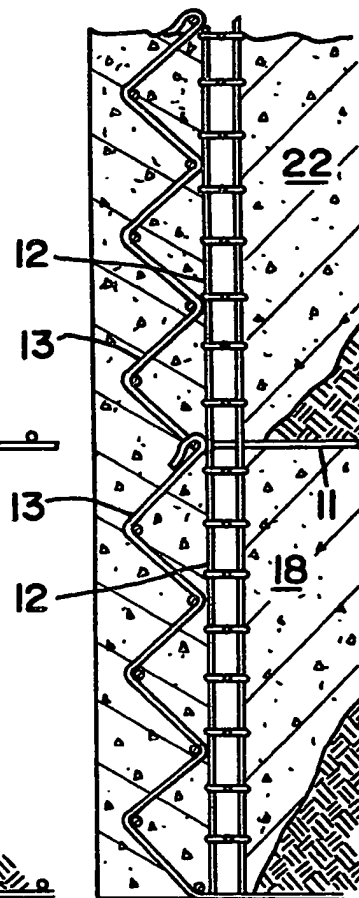
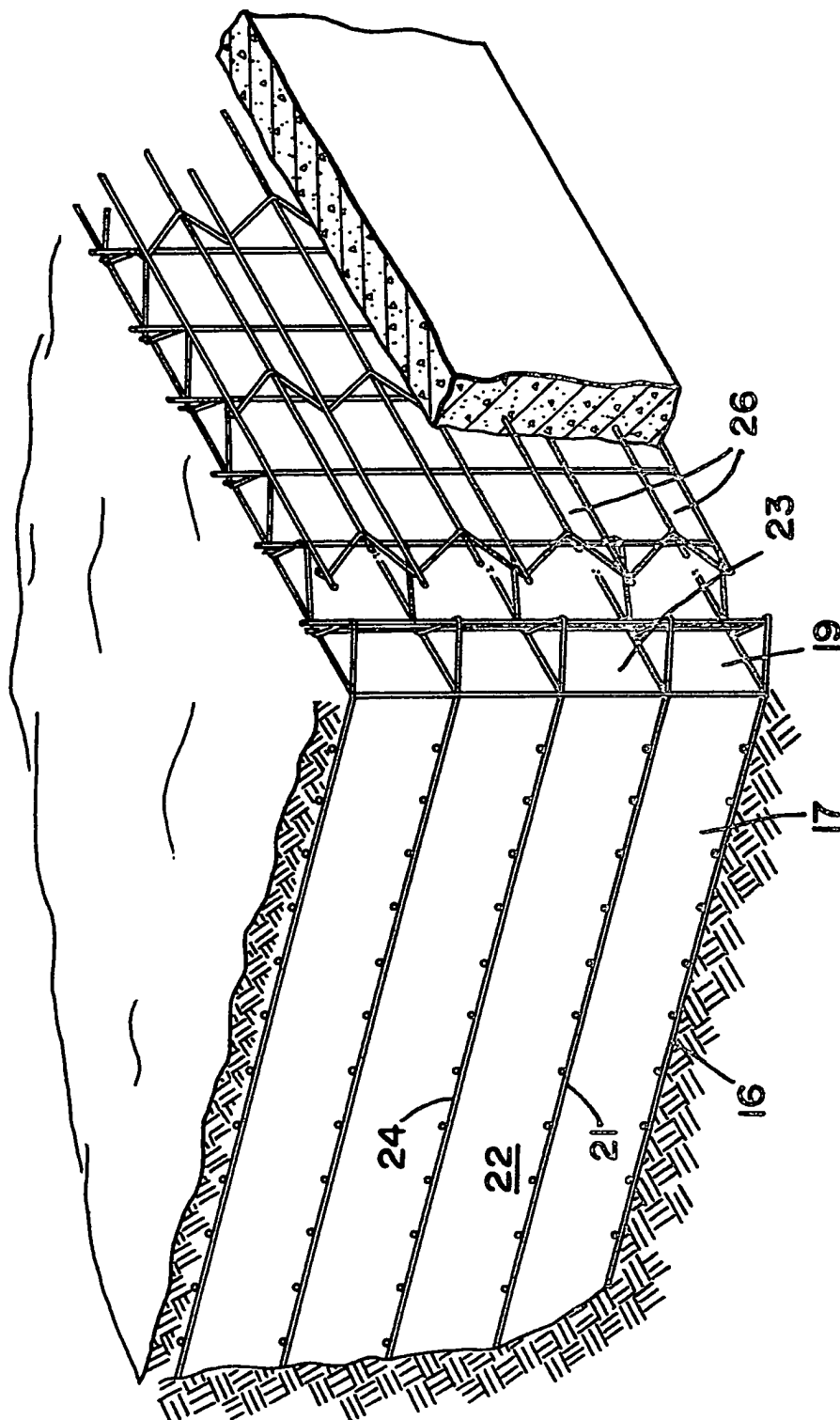


FIG. 4



15

## SPECIFICATION

## Method of and apparatus for retaining earthen formations

5 This invention concerns a method of and apparatus for retaining earthen formations.

The following United States patents comprise the closest, most pertinent prior art:

10 4,117,686  
4,324,508  
4,329,089  
4,343,572

15 These patents disclose various features of a means to retain and stabilize earthen formations in the simplest and most cost effective manner. Generally speaking, this prior art discloses the use of welded wire gridwork mats which are placed in an earthen formation in vertically stacked relationship. Generally speaking, the earthen formation is formed by a first layer of gridwork mats set in place and filled with compacted soil, sand, rocks, or the like. A second layer of mats is then placed over the compacted soil, to be followed by further layers of compacted soil and gridwork mats. At the face of the earthen formation, the edges of the gridwork mats are joined to an anchoring structure which stabilizes the face of the formation. The anchoring members may comprise upwardly angled portions of the gridwork mats which are connected to the superjacent mats to form an interlocking structure. Such an interlocking structure is more than sufficient for stabilizing a wide range of earthen formations in which the slope is not extreme and the soil is well drained and firmly compacted.

35 When the conditions of a particular earthen formation dictate, it is necessary to provide a retaining wall at the face of the earthen structure. Such conditions may include the soil character and composition, the drainage of the site, and the load to be placed on the earthen formation. For example, when an earthen formation is built up on a steep slope to support a road bed, it is usually necessary to provide a retaining wall in contemplation of the heavy load and vibration to be imparted to the earthen formation. Such a retaining wall is usually formed of reinforced concrete, either cast in place or formed of precast, reinforced concrete beams or panels.

45 To cast a reinforced concrete wall at the face of a reinforced earthen formation, the concrete reinforcing rods must be tied to the edge portions of the gridwork mats at the face of the formation. Generally speaking, this is a laborious and time consuming task, due to the fact that there are great many interconnections to be made between the gridwork mats and the reinforcing bars.

60 Much of the labour involved in forming a reinforced concrete retaining wall at the face of the reinforced earthen structure may be alleviated by using pre-cast concrete panels which are anchored to the gridwork mats in the earthen structure. However, in many remote locales it is

difficult to obtain reinforced concrete panels and difficult to ship the panels to a job site.

65 An object of the present invention is to overcome the drawbacks and difficulties as aforementioned.

70 With this object in view the present invention provides a construction for reinforcing and retaining an earthen formation having an exposed face, comprising a plurality of welded wire gridwork mats disposed in layered, vertically spaced relationship with earthen fill disposed therebetween, a plurality of corrugated welded wire backing mats arrayed in a substantially continuous layer fashion at said face and joined to the proximal edge portions of said gridwork mats to stabilize said exposed face.

80 The present invention also provides a method of forming a stabilized earthen formation having an exposed face, including the steps of; placing a first layer of welded wire work mats on a stable base, placing a first layer of earthen fill over said first layer of work mats, except for a void area adjacent to said face, placing a second layer of welded wire work mats over said first fill layer, securing a course of corrugated welded wire backing mats to the proximate edge portions of said layers of work mats, filling said void area with a rock fill extending to said backing mats, placing a third layer of earthen fill over said second layer of work mats and forming another void adjacent to said face, and reiterating said steps to form a stabilized earthen formation.

95 The present invention generally comprises a method and structure for reinforcing and retaining an earthen formation. The invention includes a plurality of welded wire gridwork mats disposed in vertically spaced relationship with compacted earth and soil disposed therebetween. At the face of the earthen structure, a corrugated welded wire backing mat is joined to the edge portions of the gridwork mats with the corrugation vertices extending generally vertically. A second layer of corrugated welded wire facing mats may be joined to the vertical corrugated mats, with the second layer having corrugation vertices extending horizontally. The corrugated mats are provided with integrally formed hook ends at least at one edge thereof to facilitate joining the facing mats and backing mats to the gridwork mats. The corrugated backing mats and facing mats stabilize and form the face of the formation, and resist vertical and horizontal bulging, respectively. The corrugated mats may also serve as the reinforcing members of a retaining wall cast in place at the face of the formation.

100 The invention will be described further, by way of example, with reference to the accompanying drawings in which:—

105 Fig. 1 is a plan view of the earthen formation reinforcement and stabilization system of the present invention, shown in an intermediate phase of construction.

125 Fig. 2 is a cross-sectional elevation taken along line 2—2 of Fig. 1;

Fig. 3 is a plan view similar to Fig. 1, but

showing a subsequent phase in the construction;  
Fig. 4 is a cross-sectional elevation taken along line 4—4 of Fig. 3;

Fig. 5 is a partially cut away perspective view of the earthen formation stabilizing and reinforcing system of the present invention.

The present invention generally comprises a method and structure for reinforcing and stabilizing a built-up earthen formation. With reference to Fig. 1 and Fig. 2, the invention provides a plurality of welded wire gridwork mats 11 disposed in generally vertically stacked, spaced apart relationship within the earthen formation. In the preferred embodiment, the welded wire reinforcing mats 11 comprise a gridwork of welded wires having transverse spacing ranging 6" to 12" and longitudinal wire spacing of from 2" to 6". The wires are preferably formed of galvanized steel, and are welded at every intersection. The wire gridwork reinforcing mats 11 are disposed in generally horizontal fashion within the earthen formation. The use of such reinforcing mats 11 is disclosed in the U.S. patents cited previously, which are incorporated herein by reference.

A significant feature of the present invention, and an improvement over the aforementioned U.S. patents, is the provision of a plurality of corrugated welded wire backing mats 12. The backing mats 12 are disposed at the face of the earthen formation, and are disposed in generally vertical fashion with the vertices of the corrugations extending vertically, as shown in Fig. 1. The backing mats 12 are formed of welded galvanized wire having a smaller spacing than the reinforcing mats 11. The backing mats 12 are joined to the proximal portions of the reinforcing mats 11 at the face of the formation, while the distal portions of the reinforcing mats 11 extend into the built-up earthen formation. The vertical orientation of the corrugation vertices provide enhanced strength to significantly reduce vertical bulging of the face of the earthen formation, as well as vertical sloping of the face of the formation.

Another salient feature which is an improvement over the prior art is the provision of a plurality of welded wire mesh corrugated facing mats 13. The facing mats 13 are oriented so that the vertices of corrugation extend horizontally and are disposed generally perpendicularly to the vertices of the backing mats 12. The facing mats 13 provide enhanced resistance to horizontal bulging of the face of the earthen formation. In addition, the mats 13 comprise or constitute excellent reinforcing members for a concrete retaining wall at the face of the earthen formation.

The corrugated facing mats 13 are provided with a height dimension substantially equal to the vertical spacing of the reinforcing mats 11. The mats 13 are formed of a heavy gauge galvanized steel wire to provide adequate reinforcement for a concrete retaining wall cast in place at the face of the formation.

An important feature of the corrugated facing

mats 13 is the provision of a plurality of hooks 14 formed at the upper edge of each facing mat. The hooks 14 are formed at the time of manufacture of the facing mats 13 by bending downwardly the uppermost extent of the upwardly extending, multiply-bent wires which form the mats 13. The hooks 14 allow the facing mats 13 to be secured to the proximal ends of the reinforcing mats 11 and to the wires of the backing mats 12 merely by looping the hooks 14 over the adjacent wires of the mats 11 and 12. In this manner the use of wire ties or hog rings is eliminated, and the amount of labour required to assemble the facing mats 13 to the face of the earthen structure is greatly reduced. It may be appreciated that the corrugated backing mats 12 may also be provided with integrally formed hook members extending from at least one edge thereof to facilitate assembly to the welded wire gridwork reinforcing mats 11.

As indicated previously, a reinforced and stabilized earthen formation is formed by stacking a plurality of reinforcing mats 11 within the earthen formation. As illustrated in Fig. 5, a first or primary layer 16 of mats 11 is placed on the surface of a site which has been excavated sufficiently to expose a stable soil or rock strata. If a stable strata is not attainable, the foundation must be formed of fill compacted to approximately 95%. A layer 17 of backfill is then placed over the primary layer 16 of mats 11 and the backfill is substantially compacted to approximately 90%. The backfill layer 17 does not extend to the plane of the face of the earthen structure. Rather, a void 18 is created adjacent to the face.

A course 19 of corrugated backing mats 12 is then secured to the lower edge of the primary layer 16 of mats 11 and a second course 21 of the mats 11 is placed over the compacted backfill layer 17. The upper edge portions of the backing mat course 19 are joined to the second course 21 of mats 11, so that the course 19 of the backing mats 12 is supported at the upper and lower edges. The void 18 of the primary layer 16 of mats 11 is then filled with crushed rock, pea gravel, or the like. This material is retained by the backing mats 12, and provides necessary drainage for the layer thus constructed.

The next backfill layer 22 is then placed over the second course 21 of mats 11, again leaving the void 18 adjacent to the plane where the backing mats 12 will be secured. The backfill layer 22 is substantially compacted, and the next course 23 of backing mat 12 is secured to the mats 11 at the face of the structure. Another layer 24 of the mats 11 is then placed over the backfill layer 22, and the backing mat course 23 is secured to the courses or layers 21 and 24 of mats 11. The void 18 adjacent to the course 23 of backing mats 12 is then filled with crushed rock or pea gravel, as before, to complete that layer. The previous steps are then reiterated until the earthen formation is built up to the desired height and grade.

In some situations, the multiple courses of

backing mats 12 at the face of the earthen structure will suffice to serve as a retaining wall. However, in many situations it is desirable to form a more substantial retaining structure at the face of the earthen formation. In those situations, a plurality of courses 26 of corrugated facing mats 14 are secured to the layers of the earthen structure as they are completed. The facing mats 13 are formed of a heavier gauge wire than the backing mats 12, and the vertices of corrugation are disposed at right angles to the vertices of the backing mats 12. A temporary concrete form is installed directly adjacent to the courses 26 of the corrugated facing mats 14, and concrete is poured within the form to fill the entire volume defined by the backing mats 12 and the earthen face and the concrete form. The result, as shown in Fig. 4, is a concrete retaining wall at the face of the earthen structure which is reinforced in both the horizontal and vertical direction by the facing mats 13 and the backing mats 12, respectively. The concrete retaining wall thus formed involves a minimum of labour in addition to the labour already expended in creating the earthen formation, and is thus a very cost effective means of permanently securing the face of the structure.

#### CLAIMS

1. A construction for reinforcing and retaining an earthen formation having an exposed face, comprising a plurality of welded wire gridwork mats disposed in layered, vertically spaced relationship with earthen fill disposed therebetween, a plurality of corrugated welded wire backing mats arrayed in a substantially continuous layer fashion at said face and joined to the proximal edge portions of said gridwork mats to stabilize said exposed face.
2. A construction as claimed in claim 1, wherein said earthen formation includes a rock fill disposed within said formation and proximate to said exposed face, said backing mats impinging on and retaining said rock fill.
3. A construction as claimed in claim 1, wherein said corrugated welded wire backing mats are each oriented with the vertices of corrugation extending generally vertically.
4. A construction as claimed in claim 3, further including a plurality of hook members extending from each of said backing mats and adapted to be joined to said gridwork mats.
5. A construction as claimed in claim 1, further including a plurality of corrugated welded wire facing mats disposed exteriorly of said backing mats and joined thereto in contiguous fashion.
6. A construction as claimed in claim 5, wherein said facing mats include a plurality of hook members extending therefrom and adapted to be joined to said backing mats.
7. A construction as claimed in claim 5, wherein said corrugated welded wire facing mats are each oriented with the vertices of corrugation extending generally horizontally.
8. A construction as claimed in claim 7, further including a concrete retaining wall disposed adjacent to said face and incorporating said facing mats therein as reinforcing members.
9. A construction as claimed in claim 8, wherein said facing mats are formed of a larger diameter wire than said backing mats.
10. A method of forming a stabilized earthen formation having an exposed face, including the steps of: placing a first layer of welded wire work mats on a stable base, placing a first layer of earthen fill over said first layer of work mats, except for a void area adjacent to said face, placing a second layer of welded wire work mats over said first fill layer, securing a course of corrugated welded wire backing mats to the proximate edge portions of said layers of work mats, filling said void area with a rock fill extending to said backing mats, placing a third layer of earthen fill over said second layer of work mats and forming another void adjacent to said face, and reiterating said steps to form a stabilized earthen formation.
11. A method as claimed in claim 10, further including the step of securing a layer of corrugated welded wire facing mats exteriorly of said backing mats, said backing mats and facing mats having corrugations extending in generally mutually orthogonal directions.
12. A method as claimed in claim 11, further including the step of providing a plurality of integrally formed hook members extending from said facing mats and disposed to engage said backing mats.
13. A method as claimed in claim 11, further including the step of casting in place a concrete retaining wall at said face of said earthen formation, said facing mats being incorporated in said retaining wall as reinforcing members.
14. A method of forming a stabilized earthen formation substantially as hereinbefore described with reference to the accompanying drawings.
15. A construction for reinforcing and retaining an earthen formation substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.
16. An earthen formation as claimed in any preceding claim and as illustrated in the accompanying drawings.